ARIZONA TRANSPORTATION RESEARCH CENTER

RESEARCH NOTES:

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CONTINUOUS EVALUATION OF IN-SERVICE HIGHWAY SAFETY FEATURE PERFORMANCE

Modern roadside safety features have been designed and crash tested to meet National Cooperative Highway Research Program (NCHRP) Report 350 guidelines. Although these guidelines assure that safety devices function well for the impact and testing conditions set forth in the guidelines, there are many unknowns and concerns about the long-term field performance of most roadside features. Differences between field performance and crash test results can arise due to many factors, including:

- Field impact conditions that are not included in crash test guidelines, such as non-tracking and side impacts.
- Site conditions that adversely affect vehicle kinematics before, during, or after impact with the safety device, such as roadside slopes and ditches.
- Performance sensitivity to installation details, such as soil resistance or barrier flare configuration.

The only practical method for generating field performance data for roadside safety features is through in-service evaluation. Further, due to the large numbers of accidents that are normally required to evaluate the relative performance of various safety features, a continuous evaluation procedure is highly desirable. The procedure should allow transportation engineers to identify the overall real-world safety performance of a feature, as well as to identify potential weaknesses or problems with the design.

The objectives of this research project were: to develop a program for the Arizona Department of Transportation (ADOT) to conduct continuous in-service evaluation of highway safety features, to evaluate this program through field trials, and to work with other states to develop a nationwide database of in-service evaluations of highway safety features.

In-Service Evaluation Program

A proposed continuous in-service evaluation program was developed with four major subsystems:

- Level I - Continuous Monitoring Subsystem.
- Level II - Supplemental Data Collection Subsystem.
- Level III - In-Depth Investigation Subsystem.
- New Product Evaluation Subsystem.

The Level I subsystem is the continuous element and the backbone of the in-service evaluation program. A computer database will be created by merging four key ADOT data files: highway and traffic data, accident data, maintenance data, and roadside feature inventory. With the exception of the roadside feature inventory, which is currently under development, the other data files are available and can be linked together under a common location identification system. The database will be analyzed periodically to produce standardized reports for generalized trend analysis and problem identification, such as:

- Frequency (or rate) and severity of reported and unreported accidents involving various roadside features, broken down by year, highway type (or functional class), traffic volume for each District and statewide.
- Trend analysis of frequency (or rate) and severity of reported and unreported accidents involving various roadside features.

The database can also be used to conduct comparative analyses on an ad hoc basis for selected roadside safety features and highway sections, such as:

- Comparison of frequency (or rate) and severity of reported accidents and unreported accidents before and after installation of median barriers.
- Trend analysis of frequency (or rate) and severity of reported accidents and unreported accidents involving various roadside safety features for specific highway sections.

The Level II supplemental data collection system complements the Level I continuous monitoring subsystem with field collection of data on the roadway, roadside and selected safety feature, and manual review of hard copies of police accident reports to obtain information otherwise not available from the computerized database. Studies under the Level II subsystem will be conducted on an ad hoc basis for selected roadside safety features that complement each other. Examples would be:

- Comparison of safety performance between different guardrail types as a function of highway type, speed limit, lateral offset, mounting height, etc.
- Effect of sideslope and lateral placement on guardrail performance.

The Level III in-depth investigation subsystem involves in-depth investigation of selected accidents, including reconstruction of the crashes to estimate impact conditions and to assess the performance of roadside safety features. This subsystem will be used in selected studies where the highest level of detail is deemed necessary. Unfortunately, this subsystem would require resources beyond what ADOT has currently or will have in the foreseeable future. Thus, despite the importance of the in-depth accident data to the understanding and resolution of problems associated with the impact performance of roadside safety devices, the establishment of this subsystem is not recommended at this time.

The new product evaluation subsystem is targeted at problems encountered with the construction, installation and maintenance of new roadside safety devices. Also, accidents involving the new devices will be monitored to identify potential problems with impact performance.

A major part of the new product evaluation subsystem is also in place already with the checklists for new constructions. It is a relatively small incremental effort to add the reporting form for maintenance personnel in order to identify potential maintenance problems, as well as to keep tab of reported and unreported accidents involving these new devices. Any information on potential problems on the impact performance of new devices would be invaluable and well worth the effort to gather it.

One critical element for the success of the in-service performance evaluation program is the choice of a program manager. The program manager will be responsible for the planning and conduct of the program as well as coordination with cooperating agencies, both within and outside of ADOT. It is also recommended that a Technical Advisory Committee (TAC), consisting of representatives from the cooperating agencies, be established. The purposes of the TAC are:

- Provide guidance and assistance to the program manager,
- Assure that the program manager has the necessary cooperation among the participating agencies.
- Decide what safety feature(s) should be evaluated under the program, and
- Review evaluation results and recommended actions.

Field Trial

A field trial of the Level II supplemental data collection subsystem was conducted with the assistance of the ADOT Phoenix Maintenance District and the Arizona Department of Public Safety (DPS).

The cable median barrier was selected for the field trial for several reasons. First, the use of cable barriers in medians is a relatively new safety countermeasure, but is gaining popularity due to increased concerns over cross-median

accidents at these locations. It is important to make sure that the cable median barrier is performing as intended. Second, the number of expected accidents is large enough for a sufficient sample size to be collected over a short time period. Third, the design for the in-service evaluation of the cable median barrier is relatively simple.

A 9.96-mile section of SR 51, the Squaw Peak Freeway in the Phoenix Maintenance District, with an average of 9.88 reported accidents per month, was selected for the study. Accidents involving cable median barriers, both reported and unreported, were identified over a three and a half month period (11/22/01 through 3/3/02). Supplemental field data were collected at each accident site and the police accident (DR) reports were obtained from the DPS.

A total of 28 cases were identified in the field trial, including 21 reported accidents and 7 unreported incidents. While the purpose of the brief field trial was to evaluate the feasibility of the Level II supplemental data collection subsystem and the sample size is relatively small, there are some useful insights regarding cable median barriers that could be gleaned from the limited data, highlights of which are:

- The extent or rate of unreported crashes involving cable median barrier is 25 percent.
- There was a clustering of 7 incidents between roadway milepost 9.0 and 9.9.
- There is little variation in roadway characteristics among the crash sites since a single highway section was selected for the study. Consequently, no evaluation can be made regarding the effects of some of the roadway characteristics on cable median barrier crashes, such as lateral offset of the cable barrier, shoulder width, slope type and rate, and barrier height.
- The length of contact with the struck barrier ranged from 1.5 to 105 meters (5 to 344 ft) with an average of 23 meters (75 ft). The number of damaged posts ranged from 1 to 25 with an average of 6 posts. There was no reported incident of broken cable, damaged splice, or damaged anchor.
- Light trucks, i.e., pickup trucks and sport utility vehicles, accounted for 25 percent (5 of 20) of the involved vehicles with the remaining incidents involving passenger type vehicles (75 percent).
- The majority of the involved drivers were male (59%) and under the age of 45.
- The injury severity for the 21 reported accidents was very low. The most severe was a non-incapacitating injury in one accident, with minor injuries in four more accidents. There were 11 accidents with no injuries, and four with unknown injuries.

The field trial clearly demonstrated the feasibility of the subsystem. There are some areas that can be improved to foster more smooth and efficient operation in future studies, such as the time lag in acquiring DR reports, manpower requirements, training for investigators, etc.

Proposed National Center

The conceptual framework of a proposed National Center for In-Service Performance Evaluation of Roadside Safety Features was developed under this study and was presented in a white paper. The objectives of this proposed National Center are to:

- Compile and disseminate available information on in-service performance evaluation.
- Provide a single point of contact for questions and technical support and exchange of information on in-service performance evaluation.
- Provide a focal point for future conduct of in-service performance evaluation studies, including multi-state, pooled fund studies.

The scope of the proposed National Center would include the following tasks:

1. Collect and compile available information on in-service performance evaluation.
2. Critically review available information on the validity and usefulness of in-service evaluation.
3. Create a national database on in-service performance evaluation.
4. Prepare bibliography and summary reports on individual roadside safety features.
5. Develop a web-based system for querying the national database, posing of questions, and exchanging information.
6. Convert existing information to electronic format.
7. Disseminate information upon request.
8. Provide technical support upon request.

9. Monitor ongoing studies pertaining to in-service performance evaluation and update the database as studies are completed.
10. Conduct studies on in-service performance evaluation, including multi-state, pooled-fund studies.

For an undertaking such as the proposed National Center to be successful, it is critical to have the proper organization and funding sources. The effort will have to be at the national level, or at least involve a number of states.

A responsible agency will have to take the lead to initiate and direct the proposed National Center. One logical choice for this responsible agency would be the AASHTO Task Force on Roadside Safety, and another is the Mid-States Pooled Fund Program administered through the Nebraska Department of Roads.

The creation of a national database and center on in-service performance evaluation of roadside safety features would have significant benefits for all transportation agencies that are involved with roadside safety. The database would provide transportation and research agencies with ready access to information on real-world impact performance of various roadside safety features. Examples of how the information may be utilized include, but are not limited to, the following applications:

- Selection among competing roadside safety appurtenances.
- Identification of performance limits.
- Field trials of new roadside safety appurtenances and features.
- Establishment of upgrading policy.
- Assessment of relevance.

Recommendations

It is recommended that ADOT consider the establishment of a continuous in-service evaluation program. The program may be implemented in phases, depending on the availability of manpower and resources. The various steps in the establishment of the program, not necessarily in sequential order, would be:

- Assign a program manager and a technical advisory committee to direct and oversee the effort.
- Develop a roadside feature inventory file and merge it with other existing data files to create an integrated database for the Level I continuous monitoring system.
- Develop the standardized reporting to be generated from the database.
- Expand the current scope of the new product evaluation subsystem to include maintenance and accident data.
- Conduct supplemental field data collection on selected roadside safety devices as the need arises.

Given the lack of trained and experienced field investigators, the Level III in-depth investigation subsystem is not recommended for ADOT's implementation at this time. However, to truly understand and evaluate the impact performance of roadside safety devices, in-depth investigation would be necessary. Perhaps this subsystem's goals can be accomplished using outside contractors on a project-by-project basis or, better yet, as a part of the National Center for In-Service Performance Evaluation.

The proposed establishment of a National Center for In-Service Performance Evaluation of Roadside Safety Features would be desirable, not only for ADOT, but for other state transportation agencies as well. This National Center would provide a single point of contact for information and technical support on in-service performance evaluation, and a focal point for future conduct of in-service performance evaluation studies.

There appears to be interest in such a National Center among some state transportation agencies. It is recommended that this idea be pursued further, particularly with the AASHTO Task Force on Roadside Safety, or the Mid-States Pooled Fund Program.

Note: The full report on this research project, *Continuous Evaluation of In-Service Highway Safety Feature Performance*, by King Mak and Dean Sicking (Arizona Department of Transportation, Report FHWA-AZ-02-482, dated September 2002) may be obtained by faxing a request to 602-712-3400, or, from the ATRC Publications web link at: www.dot.state.az.us/ABOUT/atrc/Index.htm.